Effect of short-term conservation agriculture on soil organic C and N in lowland rice agroecosystem in Cambodia

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Keywords: No-tillage, rice cropping patterns, cover crops, soil organic C, total N

Introduction

Land uses and management practices that improve soil fertility and productivity have gained attention globally. Recently, many studies have reported the crucial benefits of conservation agriculture (CA) which based on no-tillage, rotation/diversification, and cover crops, on soil fertility compared with conventional tillage (CT) in upland, but there is little information of lowland rice.

Material & Methods

- Soil samples obtained after 4 years of cultivation in 2014.
- An adjacent natural vegetation (NV) selected as reference.
- SOC, TN, Available phosphorus (Avail-P), soil respiration (SR), nitrogen mineralization (NM), Bulk density were determined.

Land Use and Management

Fertilization: Cow manure 2 Mg ha^{-1}yr^{-1} and chemical fertilizer (52N-46P-30K kg ha^{-1}cycle^{-1})

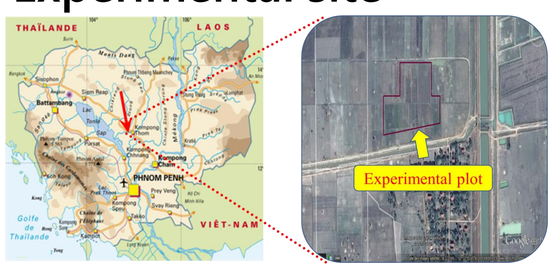
Table 1. Soil chemical properties of each cropping system and natural vegatation at 0-40 cm depth.

Soil Depth (cm)	1 rice yr^{-1}		2 rice yr^{-1}				3 rice yr^{-1}		Natural vegetation
	CT	CA	CTa	CAa	CTb	CAb	CT	CA	
SOC (Mg C ha^{-1})									
0-5	8.2	9.0	3.8b	5.7a	4.6b	7.9a	3.2b	7.2a	15.5
5-10	7.9a	4.8b	3.2	2.7	4.6	3.9	3.3	3.3	11.1
10-20	11.8a	8.5b	5.2	4.9	8.2	7.2	5.4	5.0	13.8
20-40	8.8b	12.1a	5.6	5.6	6.2b	9.8a	4.8	6.8	8.9
0-10	16.2a	13.9b	7.0b	8.3a	9.3b	11.8a	6.5b	10.5a	26.6
0-40	36.8a	34.5b	17.8	18.8	23.7b	28.8a	16.8b	22.3a	49.4
TN (Mg N ha^{-1})									
0-5	0.7b	1.0a	0.4b	0.6a	0.5b	0.8a	0.3b	0.6a	1.2
5-10	0.7	0.6	0.3	0.3	0.5	0.5	0.3	0.3	0.9
10-20	1.1	1.1	0.5	0.6	0.9	0.8	0.6	0.5	1.1
20-40	0.9b	1.6a	0.6b	0.8a	0.8b	1.2a	0.5	0.7	0.9
0-10	1.4b	1.6a	0.7b	0.9a	1.0b	1.3a	0.6b	0.9a	2.1
0-40	3.4b	4.3a	1.9b	2.3a	2.7b	3.2a	1.7	2.1	4.2
POXC (kg C ha^{-1})									
0-5	161.5b	235.3a	137.1b	248.6a	144.9b	274.0a	170.9b	321.9a	402.6
5-10	150.9a	54.4b	87.6a	67.1b	92.2a	43.7b	186.6a	130.7b	297.7
10-20	127.0a	44.1b	90.5	116.8	186.1a	61.6b	298.6a	174.4b	342.7
20-40	82.8	104.0	137.0	102.2	142.4a	116.9b	270.0	275.3	98.5
0-10	312.4	289.7	224.8b	315.7a	237.0b	317.7a	357.4b	452.5a	700.3
0-40	522.2a	437.8b	452.3	534.7	565.4a	496.3b	926.0	902.3	1141.5
Avail-P (kg P ha^{-1})									
0-5	17.1	17.1	10.2b	17.4a	9.8b	16.5a	18.6b	27.6a	8.5
5-10	11.1	10.1	13.5a	9.8b	8.3a	4.3b	18.2a	8.9b	4.4
10-20	11.7a	1.3b	14.4	12.9	12.2	9.1	16.3a	3.3b	5.8
20-40	6.7	4.6	18.3	9.8	14.0	9.1	13.8	17.6	5.1
0-10	28.2	27.2	23.8	27.2	18.1	20.8	36.8	36.6	12.9
0-40	46.7	33.1	56.5	49.9	44.4	39.0	66.9	57.4	23.8
SR (kg CO_2-Burst ha^{-1})									
0-5	11.6	15.2	15.8	24.5	11.4b	21.0a	12.8	14.8	-
5-10	11.3	7.9	11.3a	7.7b	8.2	9.4	12.7	8.2	-
NM (kg Amino-N ha^{-1})									
0-5	86.2b	157.1a	94.0b	135.0a	81.3b	115.5a	129.0	125.9	-
5-10	91.2	83.7	77.5	72.4	86.3b	107.3a	74.0	75.3	-

Different letters indicate significant difference between CA and CT within the same rice cropping pattern at each soil depth (Student's t-test; P<0.05).

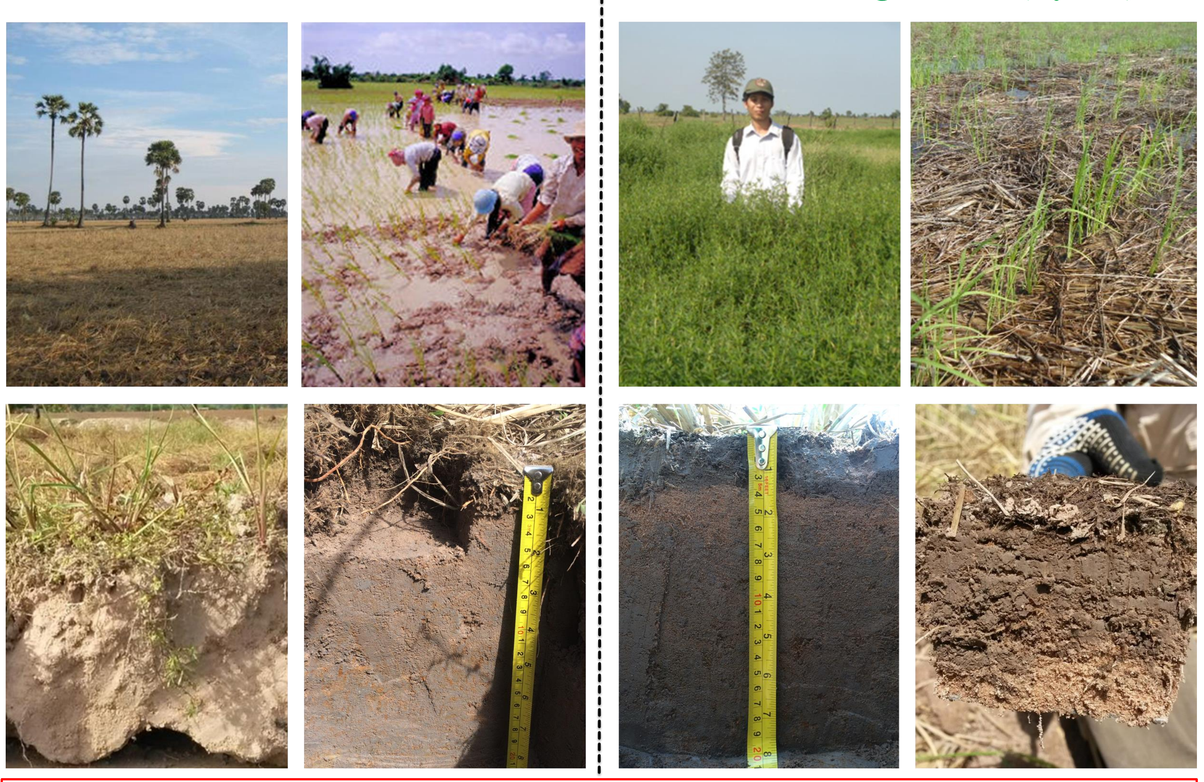
Objective: To evaluate the effects of conservation agriculture with different rice cropping patterns on soil organic C (SOC) and total N (TN) in tropical lowland rice agroecosystem in Cambodia.

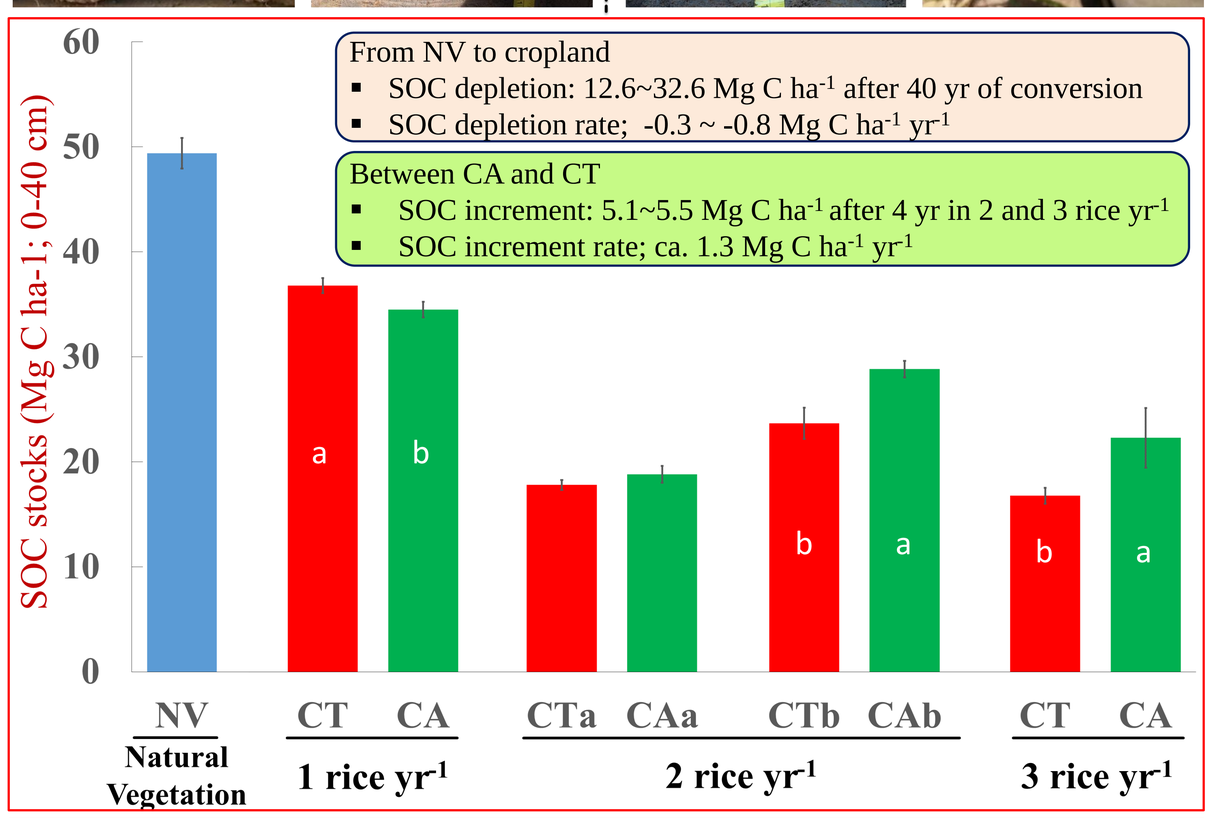
Experimental site



- Soil type; Red-yellow Podzolic soil
- Soil texture; Sand = 77.6%
- Soil pH; 4.8

Continuous plow-based tillage | **Conservation agriculture (4 years)**





Results & Discussion

- For 2 and 3 rice, larger SOC, TN, and POXC under CA at 0 to 10 cm layer, because of the little soil disturbance and greater quantity of N and C inputs.
- For 1 rice, the longer growth (Nov to May) of cover crops contributed to a higher N availability through additional biological N fixation (rhizobium), though SOC was not the case.

Conclusion

- Effect of short-term CA were clearly detected at the top 0-10 cm layer in intensive cultivation practices (2 and 3 rice per year).
- Intensive cultivation practices (2 and 3 rice per year) decreased SOC stocks, resulting in decline of soil fertility and productivity.

Remark: *Stylo. quianensis* and *Cen. Pascurum* (leguminous) used as cover crops under CA contribute ecosystem service & nutrient cycling enhancements, providing the unique benefits to resource-poor farmers, especially on poor sandy soil where the application of mineral fertilizers induces economic vulnerabilities under conventional management.